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Land administration infrastructures for sustainable development

Submitted by the International Federation of Surveyors**

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INTRODUCTION

The last decade has seen moves towards establishment of fully digitised cadastral systems throughout the world. It is recognised that cadastral systems are not ends in themselves. They are key components of more global land administration systems. These systems are tailored to facilitate an efficient land market as well as effective land-use administration and thereby, more generally, promote economic development, social cohesion and sustainable development. Digital cadastral systems thus must serve a multi-purpose use and thereby meet the challenge of a modern GIS and IT environment.

New communication technologies and the WWW have a dramatic effect on the evolving spatial information marketplace. The use of GIS in modern land administration and decision-making require standards and access tools that guide the multipurpose use of the data. Adoption of policies on Spatial Information Infrastructures provides such guidance through design of adequate concepts for data sharing and management. The paper will present a number of examples to illustrate this multi-purpose use.

It is recognised that it is difficult if not impossible to conceive this multi-purpose role without fully understanding the cultural and judicial context of which the land administration system is an integral part and which it serves. The paper therefore also discusses the issue of establishing appropriate institutional and organisational infrastructures as a crucial key for achieving sustainability in any society. In this regard decentralisation is seen as a significant key to sustainable development.

THE GLOBAL CHALLENGES

The main global drivers for change in the spatial information world can be identified as technology development, micro-economic reform, globalisation, and sustainable development (Williamson and Ting, 1999). These global drivers therefore also influence the design of adequate land administration systems and infrastructures

Technology development is the major driving force in changing the face of the spatial information world. The GPS technologies for measuring have revolutionised the traditional surveying discipline and the high-resolution satellite imagery tends to

revolutionise the mapping discipline. The database technologies for storage of large data sets and the GIS technologies for data management, analysis and manipulation arguably have had the greatest impact on the spatial information environment. And in the future the communication technologies such as the WWW and the Internet will become the focus of attention for viewing and using spatial data.

Micro-economic reform in many countries has had a dramatic impact on the spatial information environment. The micro-economic reform initiatives represent the institutional and governmental side of the changes observed during the latest two decades. This includes initiatives such as privatisation, decentralisation, downsizing, cost recovery, performance contracts, quality assurance, public/private partnership, and other policies to ensure service delivery and cost effectiveness. These initiatives have changed the focus from the pure technological issues to include also the more managerial components of designing national spatial data infrastructures.

Globalisation is becoming a reality driven by IT and communication technologies. A globalised world is one in which political, economic, cultural, and social events become more interconnected. The process includes that events in one part of the world increasingly have potential to impact on people and societies in other parts of the world. Globalisation widens the perspectives from the local to the global level. This should lead to a world movement towards improving the quality of lives of people by thinking, working together on common concerns. Globalisation has a social, economic, political, as well as an educational dimension. The www is the most graphic example of this trend, even if the full potential of the web as an educational resource is still to be seen.

Sustainable development will be a driving force in policies developed through the decades ahead. Sustainable development means development that effectively incorporates economic, social and environmental concerns in decision making for development which thereby should "meet the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission, 1987). The professional areas of land administration and, more generally,

land management include decision making of such a multidisciplinary nature to be carried out at national, regional and local level of government.

A GLOBAL LAND ADMINISTRATION PERSPECTIVE

The International Federation of Surveyors (FIG, 1995) defines a cadastre as a parcel based and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, ownership or control of those interests, and often the value of the parcel and its improvements. It may be established for fiscal purposes (valuation and taxation), legal purposes (conveyancing), to assist in the management of land and land-use planning (planning and administration), and enables sustainable development and environmental improvement.

The cadastral infrastructure includes a unique identification of the land parcels deriving from the cadastral surveys. The cadastral identification is then seen as the core component of any land information system. It is argued that within the next ten years such land information systems will form an integral part of a model of our man made and natural environment. The model will build on the core cadastral and topographic data sets which will be complete on a country wide basis and kept up-to- date. The focus will be on providing land information to the mass market to support the land market, financial and business sectors, environmental management, land administration, urban systems and community information systems (Williamson, 1997).

A vision for the future role of the cadastre in a global land management perspective should reflect this scenario of IT development. This means that the cadastral systems must provide adequate information on the land parcels to be presented in a variety of interfaces. The design and maintenance of cadastral systems must reflect this multi-purpose use.

A cadastral vision of the future, as presented in the UN Bogor Declaration 1996, is to: "develop modern cadastral infrastructures that facilitate efficient land and property

markets, protect the land rights of all, and support long term sustainable development and land management".

In Figure 1, the cadastral system is seen as the basic infrastructure to support the different systems in the area of land management.

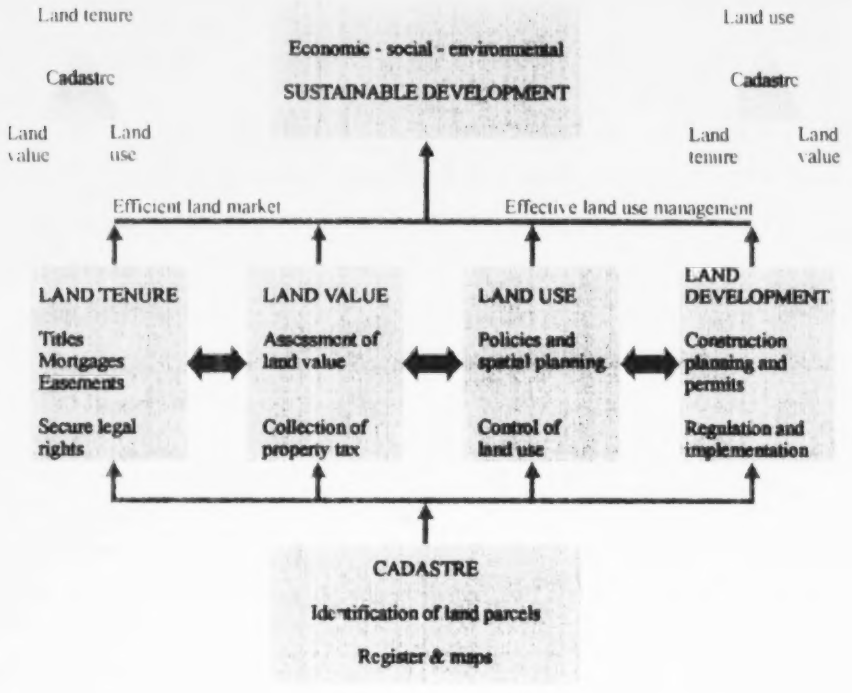


Figure 1. A Global Land Administration Perspective in support of Sustainable Development

The systems supported by the cadastral infrastructure are:

- Land Tenure System, to secure legal rights in land such as titles, mortgage and easements
- Land Value System, to assess the value of land and properties and to levy land taxes on that basis
- Land-Use Control System, to enable comprehensive and detailed land use planning control of land use

- Land Development System, to enable regulation and implementation in change of land use.

These systems are interrelated. The actual economic and physical use of land and properties influences the land value. The land value is also influenced by the possible future use of land as determined through zoning and land-use planning regulations. And the land-use planning and policies will, of course, determine and regulate the future land development.

The design of adequate systems in the area of Land Tenure and Land Value should lead to the establishment of an efficient land market; and the design of adequate systems in the areas of Land-Use Control and Land Development should lead to an effective land-use administration. The combination of an efficient land market and an effective land-use administration should then form the basis for a sustainable approach to economic, social and environmental development.

The cadastral identification of land parcels permeates through the land administration and land management systems and provides the basic infrastructure for running the interrelated systems within the areas of Land Tenure, Land Value, and Land Use. The success of a cadastral system is a function of how well it achieves these broad social and economic objectives

EVOLUTION OF LAND ADMINISTRATION SYSTEMS

Throughout the world, the cadastral concept has developed significantly over the past few decades. The most recent examples are current world concerns of environmental management, sustainable development and social justice. Due to this, multi-purpose cadastres are increasingly seen as fundamental to economic development, environmental management and social stability in both the developed and developing worlds (Williamson and Ting 1999). The cumulative evolution of the humankind/land relationship and the consequent evolution of cadastral applications are shown below.

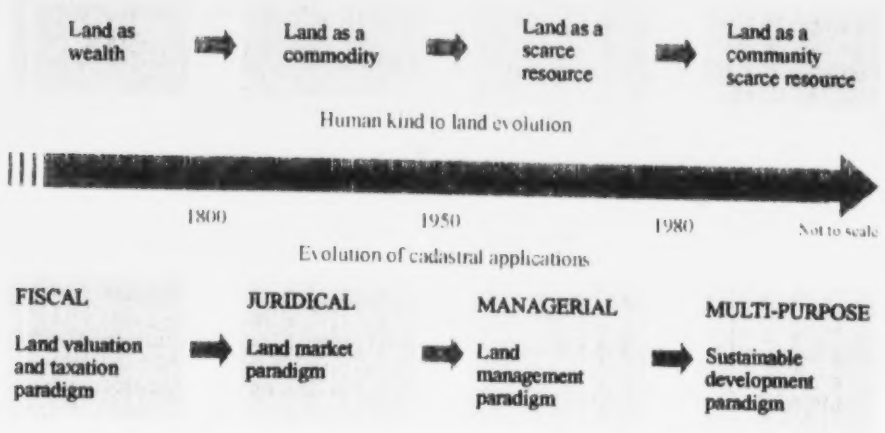


Figure 2. Evolution of Land Administration Infrastructures

The Danish Evolution

The Danish cadastre, which derived from the results of the enclosure movement, was established in the year 1844. The main purpose was the collection of land taxes from the agricultural holdings based on a valuation of the yielding capacity of the soil.

From the beginning the cadastre consisted of two parts: the cadastral register and the cadastral maps. Both of these components have been updated continually ever since. As a result, the cadastre was also used to support the land ownership and land transfer system. The Land Registry System was established in 1845 at the local district courts for recording and protecting legal rights of ownership, mortgage and easements.

In the late 1800´s the cadastre changed from being a fiscal cadastre primarily as a basis for land valuation and taxation to a legal cadastre supporting a growing land market. This evolu. The new system of title registration was based on the cadastral identification and a close interaction between the two systems was established.

During the first half of the 1900´s land was increasingly seen as a commodity and the focus was on agricultural production and industrial revolution. Land-use regulations were introduced to improve agricultural productivity and at the same time sustain the social living conditions in the rural areas. These regulations were based on the cadastral

information. In fact, the yielding valuation unit was used to control development in the rural areas until the late 1960´s. tion was completed in the first years of the 1900´s when taxation became based on the market value. Simultaneously, in the 1920´s a new Land Book System was established

The 1960´s introduced a close interaction between the cadastral process (e.g. subdivision) and the relevant land-use regulations. Any property formation or change of property boundaries must include the necessary documentation showing the approval of the future land use according to relevant planning regulations and land-use laws.

An administrative reform was adopted in the early 1970´s to reorganise regional and local administration. The reform reduced the number of counties from 25 to 14 and the number of local authorities from almost 1,400 to 275. The reorganisation created the basis for transferring a number of responsibilities and decision-making power to the counties and especially to the municipal councils by means of decentralisation. Each authority levies taxes (income and land taxes) and the elected councillors are responsible for utilising the revenue. Today, the local authorities administer more than 50 % of the total public expenditure.

Land was increasingly seen as a community scarce resource and zoning and planning regulations were introduced to control land development. Environmental concerns appeared in the late 1970´s and have developed to be the major issue through recent years. Today, comprehensive planning and environmental protection is seen as the main tools to secure sustainable development. New land administration infrastructures based on the modern IT-opportunities have evolved to support these processes of sustainable land management.

The Nordic Way

Cadastral systems have a long history in the Nordic countries. Historically the purpose of the cadastre was to collect land taxes. Today the cadastre has a much broader objective, and it is accepted that when cadastral information is a part of integrated information systems, it can improve the efficiency of the land transfer process as well as the overall process of land management. The structure of the cadastral systems,

however, varies between the Nordic countries according to the cultural and judicial setting of the individual country. The key characteristics of the systems are presented in Figure 3 (Enemark, 1998*b*).

Country	Denmark	Norway	Sweden	Finland
Area	43,000 sq. Km	324,000 sq. Km	450,000 sq. km	337,000 sq. Km
Population	5.2 mill	4.2 mill	8.6 mill	5.0 mill
Properties	About 1,5 mill	About 2 mill	About 3 mill	about 2 mill
National cadastral authority	National Survey and Cadastre under the Ministry of Housing	National Mapping Authority under the Ministry of Environment	National Land Survey under the Ministry of Environment	National Land Survey under the Ministry of Agriculture
Cadastral surveys	Licensed surveyors in private practice	Municipal Survey Authorities; Licensed surveyors in private practice will be introduced	State Survey Authorities at county level; and some Municipal Survey Authorities	State Survey Authorities in rural districts; and some City Survey Authorities
Property Register Authority (land parcels)	National Survey and Cadastre maintaining the cadastral register and the digital cadastral maps.	Municipal Survey Authorities; and the National Survey Authority maintaining the GAB-register	County and Municipal Survey Authorities; and the National Land Survey maintaining the Land Data Bank System	District and City Survey Authorities and the National Land Survey maintaining the Real Estate Register
Land Register Authority (title and mortgage)	Local district courts (Ministry of Justice)	Local district courts (Ministry of Justice)	Local district courts (Ministry of Justice)	Local district courts (Ministry of Justice)
Land Information System	Interactive subsystems linked together through a Cross Reference Register	GAB – register linked with the Land Book	Land Data Bank System	Central Information System on Real Estate Data

Figure 3. Key characteristics of the cadastral systems in the Nordic countries.

The Norwegian cadastral system is presently being revised. A new cadastral law is under preparation to come into force by the year 2001/2002. As a result of the new law the Danish and Norwegian systems are now coming closer together, just like the systems in Sweden and Finland are rooted in the same tradition. However, as a common trend in all the Nordic countries there is a development towards a multipurpose use of computerised cadastral information through interactive GIS-systems and through the Internet.

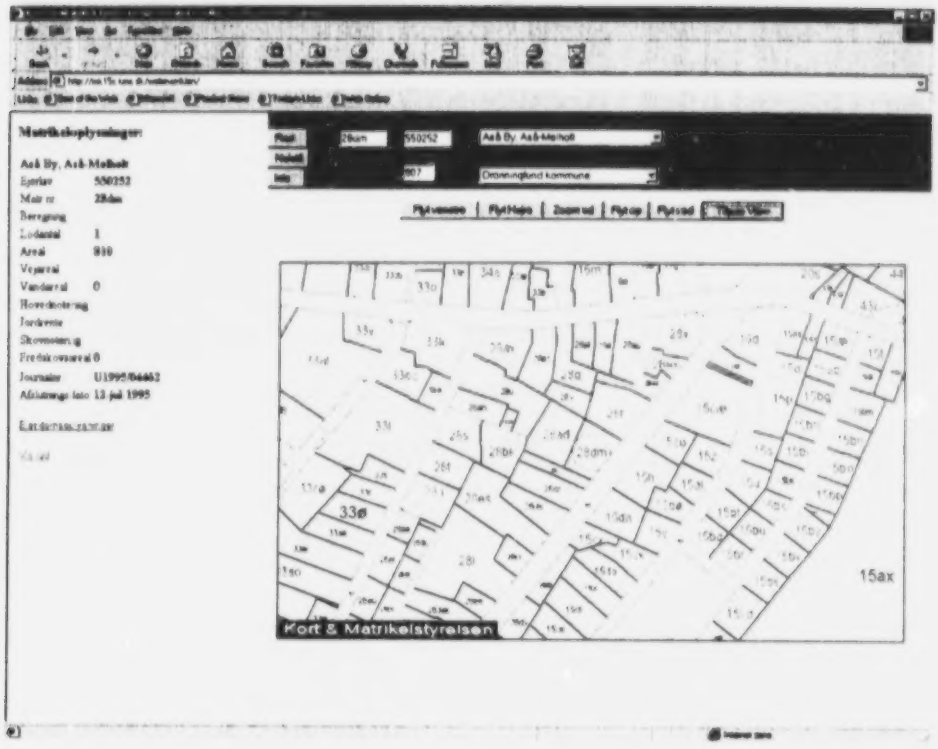


Figure 4. The Danish Cadastral Information System on the Internet. The textual information is presented on the left side of the screen by pointing on the relevant property (circled) in the map or by asking for this property by cadastral number or address. Zoom facilities etc. is available as well.

A cadastral system has two components: a textual and a spatial. The spatial part consists of the cadastral maps covering the whole country and the survey plans showing the property boundaries of the individual properties. Even though the cadastral systems are now clearly user-driven, it must be argued that within a country/jurisdiction there can be only one cadastral system and only one cadastral map providing the basic infrastructure. This means that the cadastral system must be able to serve all kind of spatial information ranging from a scale of 1:1 to a scale of 1:25,000.

To face this problem it must be understood that the origin and main objective of cadastral systems historically has been to identify the land parcels for the purpose of levying land taxes and/or securing legal and economic rights to land.

The cadastral process thus is focused on the relative accuracy between the parcel boundaries. However, today some users such as local authorities and the utilities will see the absolute accuracy as necessary in order to combine the legal property features in the cadastral map with the spatial features in the large-scale topographic map. The tension between the relative and absolute accuracy of the boundaries may therefore be seen as the main problem of establishing multi-purpose cadastral systems. The relative accuracy must be maintained for legal reasons while an absolute accuracy should be obtained for the reasons of multi-purpose use (Enemark, 1998*a*).

The problem of maintaining the digital cadastral map as described above is just one example of the complexity of the digital spatial information environment. Another example is the efforts to establish a concept for digital lodging of the survey plans and cadastral information from the private surveyor in case of parcelling out or change of boundaries. This process of digital lodging should as well be organised to serve all users even if this may an ambitious goal. This problem is currently addressed in Denmark and Finland using different approaches based on the cultural and judicial setting of the systems.

In conclusion, the spatial information management environment is changing and so is the nature of the spatial data infrastructures. Traditional isolated approaches only supporting individual purposes such as land titling or land taxation are not sustainable. They are being replaced by multi-purpose systems where information on land related issues can be integrated for a wide range of purposes, and displayed e.g. through the WWW to a wide range of users.

SPATIAL DATA INFRASTUCTURES

Spatial data infrastructures in a land administration framework provide mechanisms for sharing geo-referenced information. These mechanisms are conceptual, political and economic, and they are of course interrelated. Key elements include adoption and implementation of technical standards, adoption of access policies and cost recovery policies, and design of co-operative relationships between governmental levels and between the public and private sector.

- Conceptual mechanisms include design of organisational concepts for data sharing and custodianship, e.g. a centralised or a decentralised approach. The process of designing concepts for data sharing will always include some political and economic aspects as well. Examples of such concepts are given below.
- Political mechanisms include provision of an effective institutional framework and the distribution of power between the governmental levels. It also includes design and adoption of policies for access to data, e.g. policies for protection of privacy such as personal and financial integrity of the individual.
- Economic mechanisms include cost recovery policies as well as strategies for distribution and maintenance. The key issue here is provision of a universally accepted policy for access to data. The tension between claimed need for cost recovery and the societal benefits of free data sharing is the crucial issue in most countries when designing spatial information strategies.

Even if it sometimes may be hard to prove to traditional treasures, conventional wisdom suggests that considerable benefits flow from a well developed Spatial Data Infrastructure.

By creating an infrastructure and the relevant linkages positive results will emerge. Clear responsibility for data maintenance and upgrade will be established, duplication will be reduced and analysis improved. Sound decision-making processes are developed for governments at all levels, and valuable information is created for academic institutions, the private sector and the community. Throughout this environment there is a general expectation for the public sector to play a co-ordinating role in developing the spatial data infrastructure and for governments to initiate this process "for public good". (Grant, 1999).

Examples of the Danish approach to design of concepts for spatial data infrastructures are given below.

The GIS Concept

The Danish concept for integrated land administration is organised as a network of interactive subsystems containing the most relevant information. The cadastral register was computerised during the period 1984-86. The Land Registry will be computerised

before the end of 1999. The computerisation of the old analogue cadastral maps was ongoing for about ten years and was completed by the end of 1997. The remaining components of the system have been computerised for a number of years. The system is illustrated in figure 5.

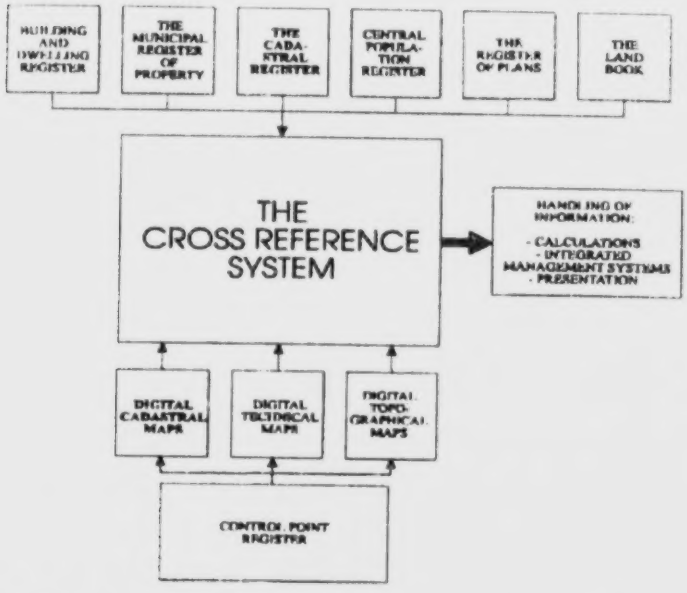


Figure 5. The Danish GIS concept for land and property data. The system includes a number of interactive subsystems linked together through the Cross Reference Register

The automatic linkage between the subsystems is achieved by establishing the Cross Reference Register, which contains all key identifications within each of the subsystems (e.g. the parcel number, the building number, the address, etc.) and the cross-reference between these identifications. This means that it is possible to obtain all available information on a specific property or building by knowing only one of the keys. Furthermore, the identification-keys are linked into the relevant physical element represented in the digital maps, e.g. the parcel, the building, etc.

Originally, only the Cadastre, the Land Book and the Municipal Register of Properties were born with a cross-reference being the cadastral identification of the land parcels. The various other real property registers are established for specific administrative

purposes. The Cross Reference Register was then established to provide the interaction between all separate registers. The same result could have been achieved by gathering all real property information in just one big register. This was, however, never considered as an adequate solution in Denmark.

The main feature of this cross-reference concept is that the daily running of the individual subsystems is decentralised in such a way that the maintenance should relay on an integration of the data-collection within the administrative routines. The responsibility for the vitalisation of the systems should rest with those (custodians) who need the data and therefore care for the updating procedures and the applications as a part of their daily administrative routines. The digital cadastral system is designed for application into this GIS-concept, and the benefits for improving the process of land management should be obvious. (Enemark, 1994)

The Planning Concept

The system of Planning Control is based on the principle of framework control, in which plans must not contradict the planning decisions at higher levels. The county councils carry out regional planning with emphasis on the regional infrastructure and the sectoral interests of the countryside. The municipal councils are responsible for municipal planning with emphasis on the local issues and the function and development of the urban areas. The municipal councils are also responsible for the legally binding detailed planning of specific neighbourhood areas, and for the granting of building permits that serve as a final control-plug in the system (Enemark, 1999).

The system of planning control is supported by a number of the sectoral land-use acts such as the Agricultural Holdings Act, the Environmental Protection Act, and the Nature Protection Act. The sectoral land-use provisions are managed by the county and municipal authorities on the basis of sectoral land-use programmes that also form the basis for comprehensive planning at regional and local level.

Furthermore, the system of planning control is supported by appropriate and updated Land-Use Data Systems, such as the Cadastral Register, the Land Book, and the

Building and Dwelling Register. These registers are organised to form a network of integrated subsystems and are connected to the cadastral and topographic maps. The total land-use management concept is presented in Figure 7.

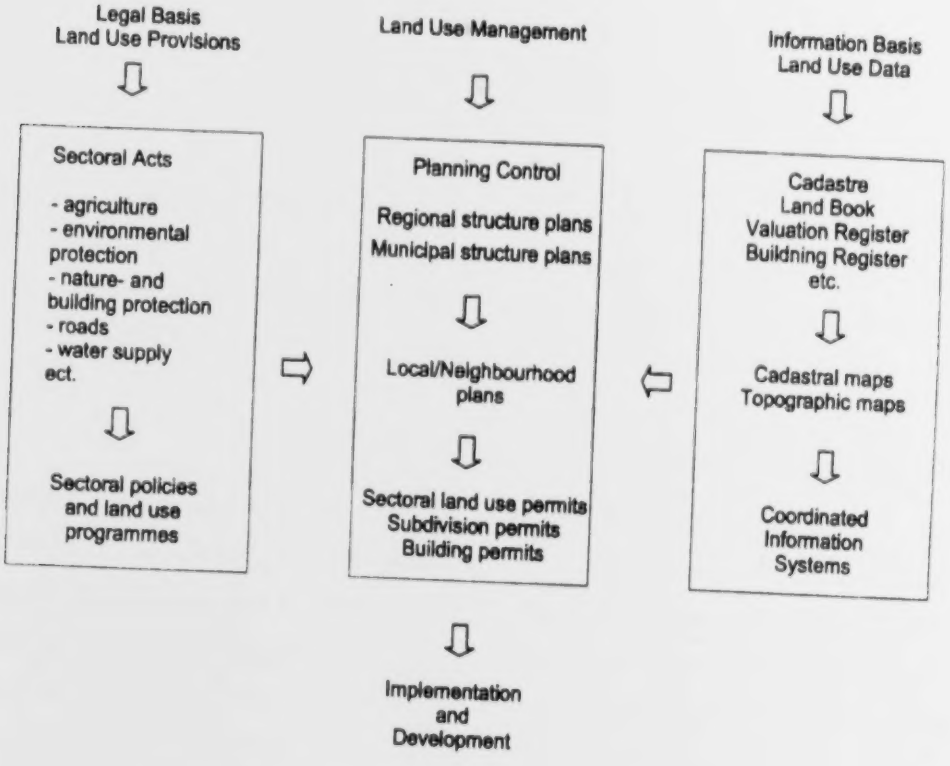


Figure 7. The Danish Concept for Land Use Management

The cadastre is increasingly used as a basic instrument in the planning process. Some local authorities use the cadastre map as the basic layer in the municipal structure planning. This digital process provides a number of opportunities. The land-use regulations are easily identified on the relevant properties with links to the addresses and name of the owners. The detailed regulations such as zoning and building restrictions can be identified on the relevant properties and located according to the property boundaries. This facility is also used when presenting the planning regulations on the Internet. The citizens can then achieve any relevant planning information just by asking for the specific property.

The WWW is increasingly seen as the best alternative to delivering spatial information by public bodies to the public and to professional business but also between public bodies. And some government organisations are increasingly seeing their information strategy based on the WWW. The decentralised databases and map servers now allow government institutions to combine cadastral information with different kind of land and property information that in an interactive way show the legal situation of land to any kind of Internet users.

The Danish municipal and county administrations increasingly present all relevant land use information including restrictions and responsibilities on the WWW. This trend is becoming vital to the management of land resources and it contributes to sharing also the democratic process of political decision-making regarding land use issues.

The educational challenges

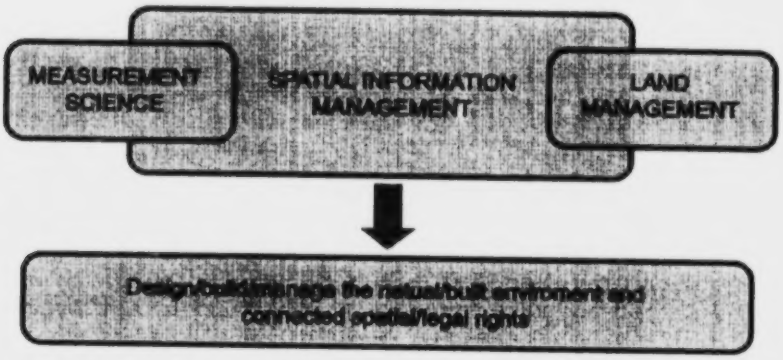
The developments as discussed above have a significant educational impact. Taking a land administration approach to surveying education, there is a need to change the focus from being seen very much as an engineering discipline. There is a need for a more managerial and interdisciplinary focus as a basis for developing and running adequate systems of land administration.

Surveying and mapping are clearly technical disciplines (within natural and technical science) while cadastre, land management and spatial planning are judicial or managerial disciplines (within social science). The identity of the surveying profession and its educational base therefore should be in the management of spatial data, with links to the technical as well as social sciences.

The systems of land administration have moved away from being "provider" driven to now being "user" driven. They are interdisciplinary by nature and they will require skills for management and problem-solving in order to serve their clients. The ability to access, to interact with and to contribute to a wide range of public and private databases at a distance will become the norm in many areas of surveying. Again, this will change

the skill-base of the surveying workforce, the structure of the organisation and, especially, the tasks of those surveyors holding managerial responsibilities.

The challenge of the future will to implement this new IT-paradigm and this new interdisciplinary approach into the traditional educational programmes in surveying and engineering. A future educational profile in this area should be composed by the areas of Measurement Science and Land Management and supported by and embedding in a broad interdisciplinary paradigm of Spatial Information Management. Such a profile is illustrated in the figure below.



THE EDUCATIONAL PROFILE OF THE FUTURE

Another educational challenge relates to the concept of lifelong learning. It must be understood, that university graduation is not the end in itself but only the fist step in a lifelong educational process. There was a time when one qualified for life, once and for all. University graduation was the ticket for a lifelong professional career. This is no longer true. Today, one must qualify constantly just to keep up. The idea of "learning for life" is replaced by the concept of lifelong learning. The response of many professions to this challenge has been to promote the concept of Continuing Professional Development (CPD).

It is also recognised that there is a significant need for capacity building in this area of interdisciplinary land administration, especially in developing countries and countries in transition, to deal with these complex issues of building sustainable infrastructures.

Capacity building in land administration is not only a question of establishing a sufficient technological level or sufficient economic resources. It is mainly a question of understanding the interdisciplinary and cross-sectoral nature of land administration systems and understanding the need for human resource development in this area. The capacity building should ensure, that the focus be more on building sustainable institutional infrastructures rather than building just high level IT-infrastructures.

The Institutional challenges

As stated in the introduction, the issue of establishing appropriate institutional and organisational infrastructures is seen as a crucial key for achieving sustainability in any society. In a theoretical sense, "institutions are the rules of the game in a society or, more formally, the humanly devised constraints that shape human interaction" (North, 1990). Institutions are the formal and informal rules, norms and standards guiding human choices and behaviour. It also includes implementation aspects such as enforcement mechanisms. Agencies, organisations and persons are actors. North uses the analogy of a football match. The institutions are the rules of the game; the teams and players are the actors. Property right is such an institution in society and the cadastre plays a most important role to make the institution of real property right work by facilitating and reducing the costs in a variety of transactions such as land transfers, land taxation and control of land use and land development.

Another institutional challenge is about establishing a suitable balance between national policy making and local decision-making. This challenge relates to the issue of decentralisation with regard to the delegation being made between governmental levels. This issue is addressed below and relates very much to the trust which the local community culturally is prepared for to have in the outcome of the decision making process.

SUSTAINABLE DEVELOPMENT

A global approach to land management, as presented above, depends on appropriate structures of governance. In this regard, the issue of decentralisation may be seen as a significant key to achieving the general aim of sustainable development.

Decentralisation of land-use planning and decision-making immediately raise the question of suitable local institutions and organisations for managing these tasks. Such local institutions and organisations must be able to handle conflicts in a very concrete and direct sense. In the context of sustainability, the conflict between immediate gains and needs on one hand, and the concern of future generations on the other, is of course crucial. This relates to the core content of the term "sustainable development" defined as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission, 1987).

In the Nordic setting, and many other places around the world, the obvious local arena for land-use planning and decision-making has been the commune - the municipality. The concept of decentralisation has developed through the 1900´s. A breakthrough, as described above in the case of Denmark, was achieved in the early 1970´s by implementing the reform of local governance. The objective of this reform was to establish local authorities being sustainable in a political and economical sense and being able to manage an increasing number of tasks transferred from the national to the local level.

This movement of decentralisation was based on democratic ideals or conceptions such as to establish a local representative democracy comprising a decentralised comprehensive approach to local self-government and a local modernised unitary administration. These ideals developed in society through the second half of the 1900´s and they are still developing. Today, the conceptions regarding local self-government are directed more towards expectations of prosperity and performance of balanced control towards sustainable development in a local as well as global sense. For example, it is politically understood that environmental problems can only be solved by involving/mobilising the local people.

Subsidiarity

The principle of subsidiarity is useful in considering the role of central and local government in land-use management for sustainability. Subsidiarity governs the

distribution of competencies between jurisdictional levels in federal countries and is also used in the allocation of competencies between the national, regional and local level. The general principle is that competencies should rest with the lowest possible level of jurisdiction.

This principle is well known in the economic literature and has recently been formally adopted by the European Commission. Such decentralised provision, it is argued, will produce not only more efficient service through making better use of local knowledge, but it will also lead to greater participation and democracy, increased popular consent to government, and hence improved political stability. It should also produce increased resource mobilisation and reduced strain on central finances, greater accountability, and more responsive and responsible government in general. Therefore, it is not surprising that many countries have seen decentralisation in and of itself to be intrinsically valuable (Bird, 1994).

Another argument is, that whatever outcome may emerge from a decentralised system of decision-making it must be assumed to be the right decisions in relation to local needs. Decentralisation thus institutionalise the participation of those affected by the local decisions. This argument is particularly valid in the area of land-use decision-making and administration. Land-use planning this way becomes an integrated part of local politics within the framework of plans and policies provided at regional and national level.

In the Nordic setting, the decentralised model is based on a cultural tradition which strives for a broad political and social consensus. The concept of decentralisation comprises a precise and finely tuned relationship between a strong national authority and autonomous county and municipal councils, based on a series of laws that establish which decisions are to be delegated. The purpose is to solve the tasks at the lowest possible level so as to combine responsibility for decision making with accountability for financial and environmental consequences (Enemark, 2000).

However, the distribution of competencies between national, regional and local level will vary depending on governmental structures and the capacity and maturity of

institutions at different levels. This is particularly important in the case of countries in transition. Strict adherence to the ideal of local decision making may be counter-productive as important competencies were decentralised to regional and local government institutions before they were operating effectively (Nadin, 1999).

Sustainability

Environmental sustainability requires action at all jurisdictional levels. There are obvious global and transboundary environmental issues that need to be addressed at the international and national level. It is also generally agreed that the search for solutions to unsustainability should be concentrated at the regional and local level. This includes the complex task of policy integration through local decision making.

Central government is of course responsible for providing guidance and control within the various sectoral policy areas such as transport, housing, nature protection etc. This includes a number of potential conflicts since the policies may contradict in a way that can hardly be solved only at national level. However, in the case of Denmark, the strict sectoral traditions of handling their own affairs are now increasingly being influenced by a more integrated and environmentally sound approach. A number of action plans have been launched for providing sustainability for sectors such as energy, transport, tourism, and agriculture.

Using the Danish example, sectoral policies are implemented in different ways. Some areas such as pollution control, agriculture and nature and heritage protection are mainly implemented through vertical connection, by setting standards and regulations at national level to be administered at regional or local level. Other areas, such as transport and energy, provide a rather firm framework at national level to be further detailed through sectoral and comprehensive planning at regional and local level. Finally, areas such as housing, the environment, nature and resource management, tourism and economic development are organised by fulfilling the overall national policies through efforts of comprehensive planning based on regional and local considerations and needs.

The impact of central versus local government in support of sustainable development is a mix of vertical connections where each sectoral policy is implemented by a top- down approach; and horizontal connections where the different sectoral policy areas are balanced on the same level through comprehensive spatial planning. A sustainable approach to land use management is achieved through the planning system where plans must not contradict decision at higher levels. This principle of framework control ensures, in principle, that the regional and local decision making will be in conformity with overall national policies.

The means to make this system work are monitoring, dialogue and the national power of vetoing a proposal for a regional structure plan or a local/neighbourhood plan. The means of veto is replacing national adoption of the plans. To facilitate the planning process and to avoid the use of veto, a comprehensive national report is prepared prior to every four-year revision of the regional plans. The report presents the current preconditions for managing the national aims and objectives within specific and topical policy areas. Through this report, national interest are considered, discussed and dealt with prior to the process of revising the plans every four years. A national veto can also be imposed against a local/neighbourhood plan when national interests are at stake. The means of monitoring, dialogue and veto work this way to achieve a sustainable balance between the three levels of administration.

FINAL REMARKS

The Bathurst Declaration established a powerful link between appropriate land administration and sustainable development. This should also be seen as a result of the gradual evolution of land administration systems over time from a specific land tax and land market focus to a more managerial and multi-purpose role. This multi-purpose role should provide adequate spatial information infrastructures as a basis for sustainable decision making in all land related matters. Sustainable development is not attainable without sound land administration.

This demand for sound land administration infrastructures also requires support from a well developed spatial information infrastructure for sharing geo-referenced

information. This includes the need to adequately address conceptual issues as well as policy issues such as data access, intellectual property, cost recovery, and design of an efficient institutional framework.

A global approach to land management depends on appropriate structures of governance. In this regard, the issue of decentralisation may be seen as a significant key to sustainable development. Means of planning control, understood as land use planning and/or sectoral policy integration, play a crucial role to apply sustainable principles at all governmental levels. These principles relate to sustainable development in its broadest sense including economic, social and environmental aspects.

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Prof. Stig Enemark is Head and of the Surveying and Planning School at Aalborg University, where he is Reader in Land Management. He is Master of Science in Surveying, Planning and Land Management and he obtained his license for cadastral surveying in 1970. He worked for ten years as a consultant surveyor in private practice. He is Vice-President of the Danish Association of Chartered Surveyors and Invited Fellow of the Royal Institution of Chartered Surveyors, UK. He was awarded the Danish Real Estate Prize in 1991, and in 1994 he was appointed National Expert to the European Union within the areas of land management and spatial planning. He was Chairman (1994-98) of FIG Commission 2 (Professional Education) and he is Honorary Member of FIG. His teaching and research interests are in the areas of land administration systems and the application of cadastral systems for land management and spatial planning. Another research area is within project-organised educational and the interaction between education, research and professional practice. He has consulted and published widely within these topics, and presented invited papers at more than 40 international conferences.

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Global mapping and national mapping organizations at the turn of the millennium: the challenge of a changing world

Submitted by the Secretariat**

* E/CONF.93/1

** Prepared by Professor John E. Estes, University of California, Santa Barbara, United States of America, Chair, International Steering Committee for Global Mapping.

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Abstract

As we enter the New Millennium we are confronted with a world where the actions of humans rival natural processes as agents of environmental change. With respect to the land surface of the globe there is currently no comprehensive, coordinated, operational, science quality, global measurement, mapping, monitoring, and modeling program in existence. The facts are: Large scale datasets do not exist for most of the earth at the present time, even in highly developed countries; development of such datasets is labor intensive, in terms of both scientific and technical personnel and is, therefore, labor expensive; and, although such datasets could support a wide variety of useful applications specific to a given locale, no single use can generally justify the cost of their development. Since the late 1800s there have been attempts to create global scale maps through international cooperation. While these efforts were well meaning the challenges inherent in the production of such maps could not be overcome; challenges such as national security and national sovereignty, lack of appropriate technologies and institutional support and the lack of resources, both human and financial. Today as we move forward together toward a better appreciation of the nature and limits of our planetary resource base an important question arises: Can you imagine our world today without maps? Let us ask another question: can you imagine a world without National Mapping Organizations? Do not dismiss these rhetorical questions too quickly. Think seriously about their implications and the potential alternatives, fueled by rapidly evolving technologies, which are beginning to come into existence in some Nations. Then turn it around. If you could design the charter of your National Mapping Organization today, what would you include? The whole field of mapping is undergoing a revolution. National Mapping Organizations must change in response to advancing technology on the one hand and end user expectations on the other. What would you do to your organization to make the policy makers of your governments today so pleased with the products that its stature and funding would benefit measurably? One thing I am certain of, we must all become proactive within our own National systems. The facts are that we need to put more resources toward the science, technology, research and development, and operational aspects of large scale global mapping. Such an investment can have significant economic and security returns. From an improved understanding and management of agricultural and forest resources to identification of public health problems and the protection of diversity. From improved demographic data which can pinpoint markets or be used to mitigate suffering in times of national disasters, to a better understanding of the factors affecting freshwater quantities and quality, up-to-date

programs of mapping, and long term monitoring will help all of us.

Resources are, however, required to improve our global mapping capability, to generate the products required to support the science, planning, and resources management community. To insure that these resources are made available, each reader must become an activist. Role-up your sleeves and help.

Introduction

With respect to the land surface of the globe there is currently no comprehensive, coordinated, operational, science quality, global measurement, mapping, monitoring, and modeling program in existence (Estes and Mooneyhan, 1994). A key feature making this statement true is the inclusion of the word *mapping*. Today, no civil organization in the Federal government of the United States has a global mapping charter; no civil agency globally has the resources, or the backing of its respective government, to aggressively develop a major, high resolution, science based global scale mapping effort. The facts are:

1. Large scale, science-based datasets do not exist for most of the earth at the present time, even in highly developed countries;
2. Development of such datasets is labor intensive, in terms of both scientific and technical personnel and is, therefore, labor expensive;
3. Although such datasets could support a wide variety of useful applications specific to a given locale, no single use can generally justify the cost of their development.

There is a lack of accurate, up-to-date, geospatial data. Yet, there is no lack of issues for which such data are required. Biodiversity, demography, deforestation, desertification, freshwater resources, poverty, and sustainable economic development all are important (Htun, 1993). Important too are ecosystem health, human health, air quality, environmental treaty enforcement, and mitigation of natural disasters. A major factor hindering both scientific research and operational applications associated with these issues today is that adequate maps do not exist for many areas of the world. Depending upon scale, thematic content, and timeliness, this is equally true for both the developed and the developing world.

Many people find this hard to believe. Too often the public and the decision-makers we serve assume that the map they require exists, contains the information they seek, is accurate, and is up-to-date. Although employees of mapping organizations all know the problems associated with maps today, we must constantly remind decision-makers that information is dated when it is collected and maps resulting from such information can have limited utility in certain types of decision-making. Some mapped information is more perishable than others, e.g. continental outlines as opposed to forest clear-cutting, or urban development. We should also be aware that the value of data could many times be related to its currency. From regional planning for national sustainable economic development to understanding the current localized demographics of an urbanized area for locating a specific type of retail establishment, the spatial component of information is key in the decision making process.

We must also remind those we serve that there are a wide variety of reasons why specific types of maps may not exist for given areas. Reasons such as national security and/or national sovereignty, economic competition, pricing policies, lack of infrastructure, unavailability of technology in some nations, lack of adequate support for training and capacity building activities in some nations. The list could go on. But it is important to note here that I believe that a revolution is occurring in mapping today, fueled by rapid advances in those geospatial technologies that support mapping (e.g. Softcopy Photogrammetry, Geographic Information Systems, Global Positioning Systems, and Remote Sensing). The revolution is to some extent being inhibited by institutional inertia and lack of understanding on the part of key policy and decision-makers.

The material that follows traces the background of global map development. The focus here is on an understanding of the historical efforts that have evolved into those programs supporting the realization of improved global mapping today, with a discussion of the importance of global mapping following. Here economic and social imperatives are discussed. The paper ends with conclusions and a call for all in the mapping science to become more proactive as we seek to provide the framework information for a truly sustainable future.

Background

Murakami (1993) subdivides the history of "global geographic dataset production" into two phases. The first phase covers the period from 1891 to 1960. Murakami's second phase was the period from 1960 to approximately 1993, the time his paper is published. I believe however, that a third period of global dataset production has begun. This third phase has its beginnings in the 1993/94 time frame and is continuing today.

The first international effort directed at global geographic data collection, discussed by Murakami (1993), is traced back to 1891 when Albrecht Penck, a geographer, proposed to the world, at the Fifth International Geographical Congress in Berne, Switzerland, that each country should compile maps of their territory using standard specifications. These data could then be employed in geographic research. Substantial opposition to this idea had to be overcome, but at subsequent congresses the idea began to be accepted. Experimental map sheets were produced in several European countries and in 1909 the First International Map Committee met in London, England to discuss specifications and production methods. Agreement on specifications and production methods was reached at a second meeting in Paris, France in 1913. Both World Wars I and II had an impact on the production of these maps. Perhaps the most significant impact was the increased need for aeronautical charts driven by the evolving significance of air power. To meet this demand for map data a new International Map of the World (IMW), at 1:1,000,000 scale, the World Aeronautical Chart (WAC) was compiled. WAC map sheets were produced according to specifications by the International Civil Aviation Organization. Most of this work was done in the United

States under the direction of the U.S. Aeronautical Chart Service, now the U.S. Defense Mapping Agencies (DMA) Aerospace Center.

During World War II the U.S. Army Map Service (AMS) was also directed to produce maps at a scale of 1:1,000,000. This mapping was accomplished primarily in areas of military significance. This work by the AMS was done in collaboration with mapping organizations in the United Kingdom, Canada, and Australia. In 1953 the functions of the IMW Central Office, at the British Ordinance Survey in Southampton, England were transferred to the Department of Economic and Social Affairs of the United Nations in New York. There was concern expressed about possible duplication of the function of IMC by WAC personnel (Thrower, 1972). This concern was dispelled and it was decided to keep these two world map series separate, because their objectives are different. The IMW products are produced primarily for general and scientific purposes, while the WAC sheets are produced specifically for the aviator. It was agreed, however, that source materials should be available for the compilation of both map series and that consideration should be given to the use of a common projection and uniform sheet limits (Thrower, 1972).

At this time the millionth scale map of the world is still not complete. Some revised sheets in this series, however, have been produced. In contrast, the WAC at a scale of 1:1,000,000 was completed, in that sheets had been made for all areas of the Earth prior to 1968. Today, DMA maintains the WAC series as the Operational Navigational Charts (ONC), while the former Soviet Union and its Eastern European allies compiled international maps at a scale of 1:2,500,000 (Murakami, 1993). This product, the Carta Mira, was published by the former USSR and its allies with each of the cooperating countries having specific areas of responsibility (Thrower, 1972).

It is significant to note that all of the maps compiled during this phase were derived from larger scale existing products. Typically, this process began with the use of 1:25,000 scale maps which were successively generalized to 1:50,000, 1:250,000, and finally 1:1,000,000 (Murakami, 1993). Most of these international maps were produced for a specific purpose. The purpose was the support of military operations. The AMS maps for ground operations and the WAC/ONC products for flight operations. While the IMW products were produced to improve our understanding of global geographic conditions, most of the information depicted on these maps comes from the products developed for military operations. There is little land use information or maps and most of that which was included became quickly dated. Land cover information, particularly with respect to vegetation information, was not shown on these maps. On all of these maps the quality of the base information varies enormously from region to region depending upon the nature and availability of the source materials used in the complication of the individual products (Thrower, 1972).

The final status of these two efforts, IMW and WAC, is a good case in point with respect to the motivation of nations in the mapping area up to this time. The fact that World Aeronautical Charts are complete is because it was in the best interest of the U.S. military and civil aviation community, which has controlled a large percentage of the

world aircraft industry, to have these charts complete. On the other hand, there has not been, to date, the military, economic, or environmental imperative to complete the land areas of the world through the International Map of the World Project.

Murakami's second phase begins in 1960 with the advent of digital spatial information production and the rise of geographic information systems, remote sensing, and associated technological advances that continue today. It was not until 1967 that the Central Intelligence Agencies produced World Data Bank I and in 1969 World Data Bank II was produced, although, it was not released to the public until 1975. These early digital map products are perhaps the most well known databases of the early portion of this period.

World Data Bank I and II, however, include only vector information on coastlines and national boundaries. Since this time a number of digital global data products have emerged. From the National Oceanic and Atmospheric Administration's (NOAA) ETOPO-5 product, to the project began in 1984 by the International Geographical Union (IGU) and the International Cartographic Association (ICA) to produce a standard global dataset in modern topologically structured form (Bickmore, 1988), to the Global Land One-kilometer Baseline elevation (Globe) project and the Digital Chart of the World (DCW) small scale digital global datasets have begun to emerge (Murakami, 1993). DCW, in particular, is significant, although it contains errors whose lineage can be traced back to the quality of the source material employed in its compilation.

A variety of organizations are currently in the process of revising and upgrading the quality of this important dataset. Yet, the scale and the thematic content of these datasets still do not meet the needs of environmental planners, resource managers, or public policy decision-makers, particularly below the national scale.

As stated above, the third phase in the production of global scale datasets begins in the early 1990s and can still be characterized as dependent upon continuing advances in geospatial technologies. Yet, this new phase is different because we are now witnessing the beginnings of a nascent international infrastructure to support global dataset development. An infrastructure that, while still diffuse and only partially organized, is setting directions that can take mapping to new levels as we enter the new millennium. Three separate but related efforts deserve mention here as the type of programs that characterize this period and set it apart from Murakami's second phase of global dataset development. These projects are the International Steering Committee for Global Mapping's Global Map Project, the Global Spatial Data Infrastructure effort, and the Digital Earth Project.

Global Map

Global Map is a product of the International Steering Committee for Global Mapping (ISCGM). The concept for the development of Global Map was originally presented by the Geographical Survey Institute of Japan as a result of the call for global data in Agenda 21, the document resulting from the 1992 United Nations Conference on

Environment and Development (UNCED), held in Rio de Janeiro. The plan is for a global database that consists of elevation, vegetation, land use, drainage systems, transportation, and administrative boundaries layers. The sources for these data include the Vector Map Level 0 (drainage, transportation, populated places, and administrative units), GTOPO30 (elevation), and the global land characteristics data produced from the 1 km AVHRR land cover data (vegetation, land cover, and land use). An important characteristic of this project is the involvement of National Mapping Agencies/Organizations (NMA/NMOs) and other interested organizations in the production and contribution of data sets and the validation of their accuracy.

Global mapping, as defined by Kunio Nonomura, former director of the Geographical Survey Institute of Japan, and one of the primary instigators of the Global Map project, is a group of global geographic data sets of known and verified quality, with consistent specifications which will be open to the public, considered a common asset of mankind and distributed worldwide at marginal cost (Nonomura, 1994; Nonomura, 1996; Kidokoro, 1999).

What makes this product unique is the level of active participation and call for additional national mapping organization participation. Below, figure 1 shows the status of participation as of September 2000. There are three levels of participation in the project. These levels are defined as follows:

- Level A: provide and process data for your own country, and assist one or more Level C countries (red)
- Level B: provide and process data for your own country (green)
- Level C: provide data for their country (blue)

Level of Participation in ISCGM Global Map Project

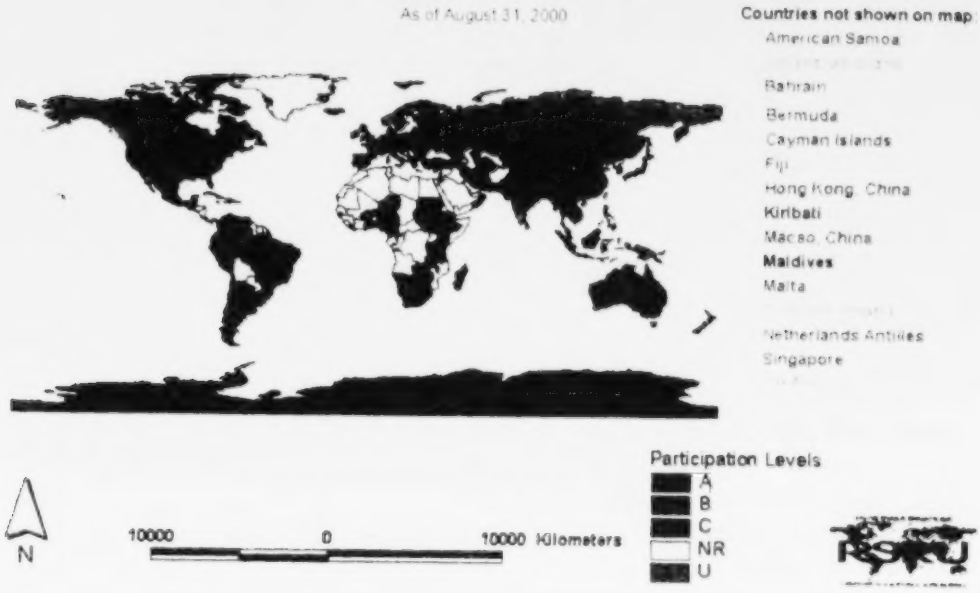

Figure 1 Participation in the Global Map project

In addition to NMOs, several organizations are participating as either full members or observers. SCAR, the Scientific Committee on Antarctic Research is participating as the representative for Antarctica. There was discussion as to whether or not CERCO, the Comité Européen Des Responsables de la Cartographie Officielle, the organization of European national mapping agencies, would represent its approximately 35 members in the Global Map project. The decision reached was that each country would participate on their own, if they so choose. Additional organizations that are represented at ISCGM in an advisory capacity include the United Nations and the United Nations Environment Programme, the United Nations University, the National Geographic Society, and the International Cartographic Association. Liaison status has also been accorded the International Standards Organization (ISO) and CEOS. Other organizations are added to the list as they indicate their interest in participating.

The effort put into this project has been significant. Meetings of the ISCGM have been held since 1994 (Tsukuba, Japan, 1994; Santa Barbara, California, 1996; Gifu, Japan, 1997; Sioux Falls, South Dakota, 1998; Canberra, Australia, 1998; Cambridge, United Kingdom, 1999; Cape Town, South Africa, 2000; Cartagena, Colombia, 2001 (planned)). During this time, several working groups have been formed to focus on specific issues, including standards and specifications. Some of these have subsequently been disbanded, their tasks completed.

Currently, data from the GTOPO30, Digital Chart of the World, and the 1-kilometer global land cover data sets have been distributed to the participating countries. These countries' national mapping agencies will then have the option of validating the data as it currently exists, or contribute more up to date national level data at the 1:1,000,000 scale. The completion date of Global Map version 1.0 is November 2000. Discussion is underway for version 2.0.

Figure 2 is an example of the Global Map product, presented by Motoyuki Kidokoro at the Cambridge Conference, July 1999.

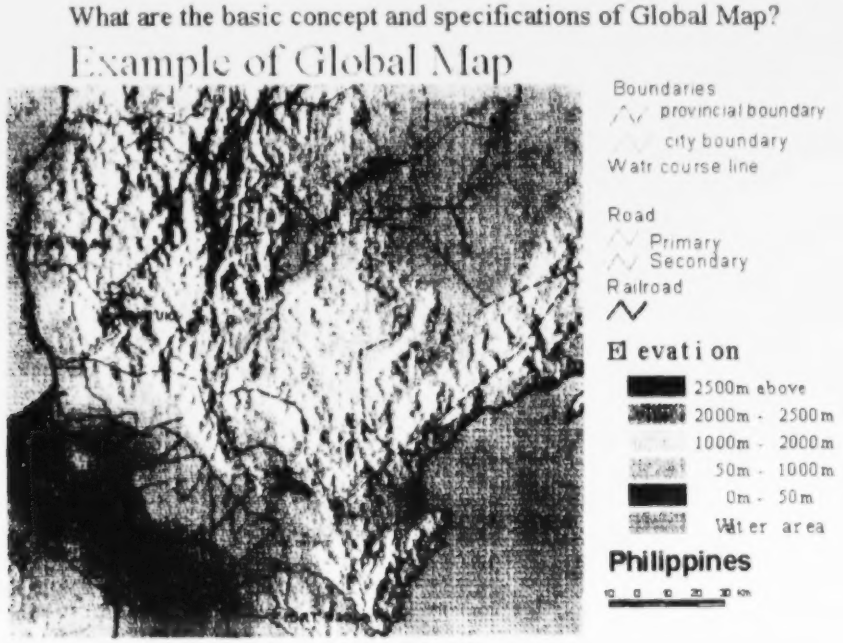

Figure 2 Example of the Global Map product (Kidokoro, 1999)

Global Spatial Data Infrastructure

The Global Spatial Data Infrastructure (GSDI) activity is comprised of a group of individuals representing national mapping agencies, international organizations, and standards organizations. GSDI was defined at the second GSDI Conference (1997) as "the policies, organizational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the global and regional scale are not impeded in meeting their objectives."

Personnel from organizations and individuals interested in the establishment of a GSDI first met September 1996 in Bonn, Germany, and focused on "The Emerging GSDI." A second meeting was October 1997, Chapel Hill, North Carolina, and the focus was "Towards Sustainable Development Worldwide." At Chapel Hill, GSDI was

defined, as noted above. Also, "one of the central findings of the 2nd GSDI Conference is that the GSDI is of vital importance to implementation of Agenda 21 of the Rio Summit and to multi-national environmental conventions and that it should be placed as central support for decision making before the meeting of the UN Commission on Sustainable Development in 2001. Further, the GSDI is critical to the attainment of substantial and sustainable development in both the developed and developing countries of the world" (1998). The third meeting, in Canberra, Australia, November 1998, focused on the "Policy and Organizational Framework for a GSDI." A primary finding from this third meeting is that "National Mapping Organizations/Agencies play a key role in ensuring that accurate, up-to-date geospatial framework data are developed and maintained. Such data are key to, among others, the promotion of sustainable economic development, improvement of environmental quality, resource management, upgrading public health and safety, modernization of governments at local, national or regional levels, and the responses to natural and other disasters. Therefore such organizations play a vital role in facilitating the development of a GSDI" (1998).

Digital Earth

The concept of Digital Earth was first publicly announced in 1998. The idea is summarized as: A Digital Earth could provide a mechanism for users to navigate and search for geospatial information - and for producers to publish it. The Digital Earth would be composed of both the "user interface" - a browsable, 3D version of the planet available at various levels of resolution, a rapidly growing universe of networked geospatial information, and the mechanisms for integrating and displaying information from multiple sources (Gore, 1998).

As a result of this challenge by the Vice President, NASA and cooperating federal agencies and industries have responded by creating a Digital Earth organization, headquartered at NASA. Digital Earth was formally defined at the 2nd Interagency Digital Earth Workshop in September 1999 as "a virtual representation of our planet that enables a person to explore and interact with the vast amounts of natural and cultural information gathered about the Earth" (http://www.digitalearth.gov). The current proposed structure for this effort includes a consortium of relevant and interested agencies and organizations, a steering committee, and a federally sponsored institute to provide administrative support (Foresman, 1999).

Digital Earth will have an effect on a wide variety of areas related to geospatial data and technology, including science and applications, standards and architecture, data access and distribution, visualization and exploration, and education and outreach. In essence, digital earth focuses on the technology, while GSDI focuses on the standards, and Global Map will provide the content.

Currently, major players in this effort include federal government agencies participating in the Interagency Working Group on Digital Earth, these include NASA, the Environmental Protection Agency (EPA), USGS. Private industry, the media, and academia are also playing roles in the U.S. Digital Earth effort. In addition, an

international Digital Earth symposium is being held on a biannual basis, the first one hosted by China, with Canada scheduled to host the second one in 2001.

Discussion

In many developing countries, even well-understood environmental changes with local causes and effects, that in the aggregate may represent a global concern, often have very low priority with officials compared to such issues as food, health care, and safety of the people. Global change issues and environmental concerns are often treated as rumors from more fortunate neighbors. In a number of countries, the high-resolution datasets needed by the world community are classified and are not permitted to leave the country in any form. In some instances where such data are exchanged with "friendly" nations, restrictive agreements limit access to these data. Even in highly developed countries, where scientific understanding is widespread, it is often difficult to generate the political and financial support for the correction of widely recognized environmental problems (Mooneyhan, 1993).

There is a growing recognition that the environmental and/or economic health of Nations affects national security. Indeed, in the United States Land Remote Sensing Policy Act of 1992 (Public Law 102-555) in its findings, Section 2. (1) finds: "The continuous collection and utilization of land remote sensing data from space are of major benefit in studying and understanding human impacts on the global environment, in managing the Earth's natural resources, in carrying out national security functions, and in planning and conducting many other activities of scientific, economic, and social importance." While an image from a satellite is not a map, it is important to note that mapping is now being done from satellite systems. The fact that United States Public Law 102-555 puts the understanding of human impacts on our global environment and management of the Earth's natural resources on a par with national security is significant.

In times of military threat maps are rapidly generated. Conditions are assessed. Positions are analyzed. Options are developed, and actions are taken. What we have today are unprecedented global, environmental, and economic threats. When we understand that our ability to create environmental change on a global scale now rivals and is surpassing that of natural factors, we have in a very real way a new type or class of national security threat. These new threats also require that we assess conditions, analyze positions, develop options, and take action. But first, we need to come to some understanding of the nature of the threat. So if we produce maps to better understand the nature of the military might we are up against, why shouldn't we also have maps that help us to better understand the nature of the social, economic and environmental issues (threats) we face?

Today's economy is most certainly a global economy -- economic downturns in one part of the world can and do have effects on other parts of the world. The financial stability, human health, environmental health, and political stability are all susceptible to events occurring around the world. Transboundary issues, such as air and water quality, shared watersheds, can have great impacts on a region's economic well-being. A number

of these issues are in the process of being covered by international conventions or protocols. Global geospatial framework data can assist in speeding the recovery from major natural disasters, such as hurricanes and earthquakes. Two specific examples are included here. The first deals with the use of geospatial data/information in times of natural disasters and the other with the use of such data in the enforcement of multi-national environment agreements (e.g. the Kyoto Protocol).

Local To Global: Example Of The Application Of Global Map Data

To demonstrate the usefulness of global map data, Researchers in the Remote Sensing Research Unit, University of California, Santa Barbara, overlaid a variety of global data sets upon imagery of the flooding in Mozambique, which occurred in March and April 2000. Their goal was to demonstrate the use of global scale data for the assessment of local to regional scale natural disasters; in this instance, to assess the extent and the effects of the flooding in the southern African country of Mozambique.

Questions asked were could data sets such as those that are available, those included in version 1.0 of Global Map, and those that may potentially be included in version 2.0, be employed within the context of a GIS that combines raster and vector data to determine:

- How many people were affected by catastrophic flooding?
- What was the total area of different land cover classes that could have been or were affected?
- How much of the transportation routes were damaged or potentially could have been damaged in the area surrounding the Limpopo River Basin, Mozambique?

Several global datasets were found to be useful for this course scale analysis. Using global to regional scale data, a disaster's affects can be mapped and assessed. Using data published by several international aid organizations, as well as maps of the flood extent that they had made using different datasets and methodologies, it was determined that their differences were considerable.

The flooding related to the Mozambique disaster events occurred during the February - April period of 2000 as a result of five large tropical storms and hurricanes, the floods that resulted covered a 50 mile wide area, displaced hundreds of thousands of people and devastated the recovering economy of Mozambique (Kriner, 2000; Murphy, 2000). Floodwater rose quickly, in one instance as much as three meters in half an hour! Winds in excess of 100 miles per hour were recorded, heavy precipitation and cloud cover hampered rescue efforts for weeks (CNN, 2000a). By April approximately 700 people were confirmed dead and nearly 1,000,000 were either homeless or in need of aid. Nearly 70 percent of Mozambique's 19 million people live in poverty, this heightens the necessity for international involvement when disaster strikes (CNN, 2000b; Datt et al., 2000). International aid organizations, along with the aid organizations of governments from the surrounding countries, began to react to the situation and assess the damage but the international community was said to have been slow to react, this could possibly have been due to the unavailability and/or inaccessibility of accurate spatial information. For

the purpose of this effort, at this time, it is unclear what information was available to those aid organizations at the time the events occurred, and on what data they based their assessment and planning. What is quite clear, however, is that the quality and value of the map data that is currently publicly available can be improved considerably by a globally consistent base dataset. Although there are many aspects to this disaster assistance effort, those who direct aid to people need access to reliable, accurate and timely spatial data upon which to base decisions.

Satellite imagery of the affected area was provided to the public by several agencies. Processed image map products derived from imagery acquired by weather satellites (Meteosat-7 and NOAA-14 AVHRR) of the hurricanes were provided on several NASA/NOAA sponsored websites. Remote sensing imagery can be used to track the progression of hurricanes, to forecast rainfall intensities and to assess damage caused by flooding. USGS, NASA and the European Joint Research Centre made Landsat 7 ETM+ as well as classified SPOT-4 image maps of the extent of the flooding available on the web as well. These images were useful for determining the extent of flooding involved, especially the SPOT-4 imagery, which was classified by the European Joint Research Centre's Space Applications Institute to show the extent of the flood for two critical periods between hurricane events, 21-29 February 2000 and 1-10 March 2000. The NASA Landsat imagery was acquired during two periods, before the flooding (August 22, 1999) and after the floods reached their maximum extent (March 1, 2000), clouds and shadows obscured some inundated areas but provided a very real perspective on the magnitude of the flooding.

Radar imagery is quite possibly the best sensor system available for mapping the flood extent of such a vast area because it is not impeded by clouds or atmospheric moisture and, due to the extreme difference in the reflective capacity of standing water and the volume scattering capacity of the closed canopies, has the capability of accurately mapping flooded vs. non flooded areas. Radarsat provided a series of images of the flooded area that demonstrated this capability. Visible wavelength imagery (i.e. Landsat 7 ETM+ and Spot 4) also showed the extent of flooding well, and by using a time series composite the flooded areas can be reasonably well classified.

Four datasets were found to be useful for deriving the aforementioned statistics: the 1-km resolution IGBP DISCover land cover dataset, the Gridded Population 4-km resolution dataset, a Land use polygon coverage at stated scale of 1:200,000 and Digital Chart of the World coverage of transportation routes, political boundaries and coastline at 1:1,000,000 scale.

Figure 3 USGS/USAID Cropland Use Intensity (1:200,000)

Figure 4 UNEP/GRID Population Density (4 km grid cells)

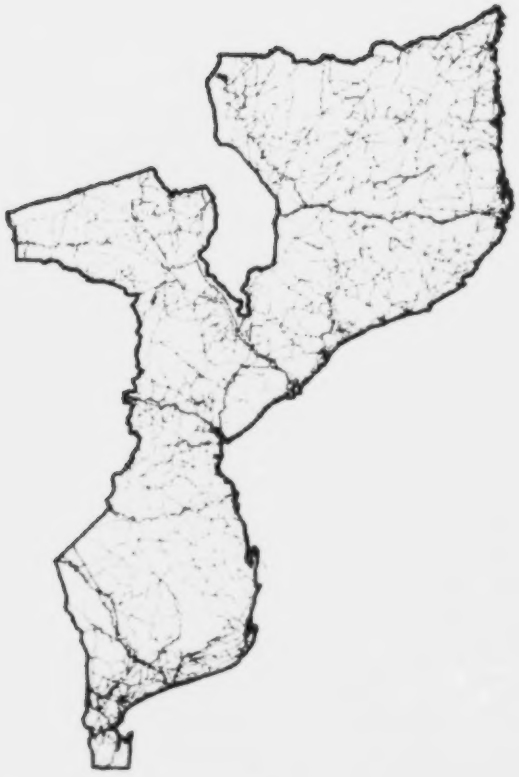

Figure 5 Roads, Railroads, Rivers, and Political Boundaries (1:1,000,000)

Figure 6 USGS/EDC IGBP DISCover (1 km grid cells)

Mapping the transportation, land cover and population density of the affected area provided a general picture of the flooded area but expectedly there were differences in the statistics derived from the base data using the flood extent maps provided by the various agencies. The nonspatial data, i.e. current mortality statistics and other site specific information, were ubiquitous due to media attention but actual map data were not. For the most part, the maps of Mozambique and the area of interest, found through numerous intensive searches, often did not have a date or source associated with them. Some of the web images were not intended for use in mapping but were never the less all there was available. It was interesting to note that a vast majority of the transportation routes, rivers and other important feature locations such as airports and towns on these maps were derived from one or two sources. These sources are Digital Chart of the World compiled by the Department of Defense and from Operational Navigational Charts, also compiled by the Department of Defense. These data are out dated, especially in poorer third world countries, but, as of this writing there is still no base map from which individual mapping programs can begin to compile globally referenced locally usable spatial information that are both relatively current and verified.

Table 1 Comparison of results from data from different agencies

	World Food Program	State Department	Joint Research Centre
	No Date	March 3	February 21-29
Affected Area (km^2)	8,253	11,514	4,239
DCW Roads (km)	907	1,296	457
DCW Railroads (km)	121	200	63
Developed, Irrigated Cropland (km^2)	377	389	324
IGBP Class 12 (km^2)	695	1,152	310
IGBP Class 13 (km^2)	285	397	166
IGBP Class 14 (km^2)	743	542	234
Affected Population (people)	526,704	544,864	376,560

The 1-km resolution IGBP DISCover land cover dataset (a Global Map data layer) downloaded from the USGS EROS Data Center was the first global scale dataset used in this investigation because it contained land use classes that encompassed human use. One of the original questions was how, and more importantly where, the flooding had affected people; how many square kilometers of cropland were flooded? Where were the urban centers within the flooded areas? How much area of mixed use (i.e. seasonal agriculture or small crop farming) was flooded? The IGBP dataset uses 17 classes to describe the earth's land surface. There were three land use/land cover classes (IGBP classes 12 (Croplands), 13 (Urban and Built-up) and 14 (Cropland/Natural Vegetation Mosaic)) that were of use in this course scale investigation into the uses of global to regional scale datasets for disaster assessment. These three classes were used to determine the number of square kilometers of land being actively used by people, or being utilized for various types of farming, that were affected by the flooding using the different flood extent boundaries. It is important to note here that in the DISCover data set the urban class was derived directly from the Digital Chart of the World and was not derived from the processing of satellite data as all other classes were. The urban class was also not subject to the validation that all other DISCover classes underwent.

The Gridded Population 4-km resolution dataset, downloaded from UNEP/GRID, was used to assess both the distribution of population density and to see how many total people, according to a sum of the clipped grid cell values, the floods potentially affected. Population density is calculated based on an interpolation of point data values and difficult to collect and update in isolated areas of sub-Saharan Africa. At 4-km, this was the coarsest global scale dataset used for this general investigation. The maps produced by clipping this dataset with the different flood extent boundaries shows the population density and allowed for tabulating the population totals, but these figures are at best rough approximations due to the nature of the data. Civil wars, drought and natural disasters over the past decade have caused large population fluctuations between the six provinces within Mozambique, these factors add to the uncertainty of this dataset. All data issues aside, this dataset did provide a general depiction of the population distribution within the extent of the flooded area but the population totals calculated from each of the flood extent maps may be in error due to many reasons, including the course resolution.

A land use polygon coverage at a stated scale of 1:200,000, downloaded from USGS Eros Data Center was the finest scale data used for this project. Being a well documented vector polygon coverage made it easily to incorporate into a GIS with the other layers. This dataset, like the IGBP dataset, contained numerous classes for use by researchers and regional resource assessment applications that were not applicable for our purposes. Two classes were extracted from this dataset, the "Developed, Irrigated" and the "Flood Recessional Agriculture" classes. Using the flood extent coverages, these extracted polygons were clipped and the areas of each were totaled. These statistics are believed to be the most accurate because they were derived from 1:200,000 scale data. Unlike the IGBP DISCover data and the Gridded Population data, which were global in scale, this data set is only reasonably applicable for regional to local scale applications. This scale restriction for global datasets however is changing with the creation of new software technologies that offer the potential for high speed virtual roaming access, via the internet, to fine scale multi-layer spatial information that is a part of a seamless globally consistent database. With the aid of high speed computing and large capacity storage hardware, scientists have the tools to access and work with global datasets.

Digital Chart of the World Level 1 coverages of transportation routes, political boundaries and coastlines were used, and served as the geographic reference for all of the other data sources collected. DCW is the digital representation of Operational Navigation Charts with an original scale of 1:1,000,000. This base cartographic map series was designed to support medium altitude route navigation, operational planning and intelligence briefings (Langaas, S and Tveite, H. 1995). Because DCW is a globally consistent vector database, it often serves as a geographic reference for many other global datasets and, most importantly, it is free and publicly available. The Roads, Railroads, and Political Boundaries of Mozambique were downloaded, imported and extracted. These layers were clipped with the different flood extent boundaries and the lengths of each set were tabulated. Because the political boundaries, rivers and roads of DCW were used as a geographic reference for registering the image maps of flood extent collected, it was feasible to co-register and compare them. Both the flood extent map produced by the World Food Program (using GTOPO30) and the map produced by the World Food Program (using "imagery, reports, elevation analysis and flood history") used these same features as a reference in their compilation. By sharing a common base layer these maps can be accessed in terms of their relative accuracy, as well as to compute statistics that can be used for disaster assessment.

UNFCC/Kyoto Protocol

Article 3 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change, signed in December 1997, requires of the "Annex I" countries (developed nations plus the FSU states) returning individually or jointly to their 1990 levels these anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol. Five greenhouse gases or classes are specifically mentioned in the Protocol: carbon dioxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. In July 1997, the U.S. Government issued a

Climate Action Report that attempted to reconcile the congeries of assumptions for the US as to sinks (e.g., forest coverage) and sources (e.g. rate of adoption of energy-efficiencies), and "emission-trading mechanisms"—factors that will determine reductions required of Annex I countries from the 1990 baseline, once the treaty is ratified.

The question arises now for all of us, just how will the baselines for Kyoto be established. A suggestion that has been made is to link emission levels to various land cover types. An important question in establishing the Kyoto baseline is the development of the linkage between source level terms for the greenhouse gases covered in the protocol and global land cover types. The next question is do we as a global community have a relevant land cover product from which the area term for each class of cover for specific geographic areas can be derived? The answer to this question at this time must be no. There are a wide range of global scale land cover maps and global land characteristics databases derived from a wide variety of sources. Which should we use for establishing the baseline land cover from which Kyoto can be measured?

Considerable discussion is beginning to occur within policy industry and scientific circles concerning the implications of the Kyoto Protocol for future economic development at scales from local to global. This discussion is already global in nature and has important implications for how the U.S. is perceived by the global community. The European Commission is in the process of focusing a research agenda entitled: "Global Monitoring for Environment and Security". This agenda is laid out in a document entitled: Global Monitoring for Environmental Security: A Manifesto for a New European Initiative. This Manifesto proposes the idea that a global environment information service would represent a significant European contribution to the implementation of the Kyoto Protocol. The document already has the formal backing of Europe's space agencies and researchers in Europe are already gearing up to address the challenge of examining how agreements such as Kyoto can be monitored and verified using a combination of remote sensing and in situ data.

An important question here is what is the role of National mapping organizations in this discussion? Space Agencies appear to be leading the way. Is this right? Is this acceptable? What can be done concerning this situation? In all of the discussions that I have been involved in concerning this issue with my European Colleagues is that Europe could care less that the U.S. has not ratified the Kyoto Protocol. They have and they will develop their own tool to verify compliance with this and other important international environmental agreements. That is they will use the data they acquire to derive the information they use in any negotiations involving questions of compliance. Is this really going to be the response of all regions of the world? Can anything be done to come up with an acceptable standard geospatial product here. If so, should not National Mapping Organizations play more of a role here?

The economic and environmental health of nations are key factors affecting national security. Better maps are a fundamental requirement if we are to improve our management of our planetary resource base and improve our economic well-being and

environmental quality. Yet, when the reasons for lack of maps are examined carefully, other than nonexistence and perhaps restrictive data policies, national security is the major factor inhibiting access to map products.

Thus we have a paradox. We need accurate, up-to-date, large scale maps to improve our understanding of the Earth as an integrated system; plan the wise use of the resources base of nations; and, to assess and monitor environmental quality at scales from local to global. Improvements in the environmental quality and economic well being of nations around the world can enhance the quality of life of peoples and improve global economic conditions. These factors can have the effect of improving our national security. On the other hand, the widespread availability of large scale maps can represent a tactical military threat. It cannot be denied that maps have and will continue to play a key role in military operations. So we have the mapping paradox. Maps used one way can improve national security, but used another way are a threat to national security.

One answer to this paradox might be that we should have such maps, but access to them should be restricted. This is the intelligence community model. The intelligence community wants to control access to data/information. There are good and valid reasons for the position. These reasons include the reduction in potential threats to the security of a nation by not allowing other nations, or in some cases even their own nationals, access to maps of sufficient quality to support military operations. If we agree that information and the control of its flow to decision-makers represents power, we have another reason for controlling access. We should also be aware that, from a decision-maker's standpoint the concept of plausible deniability applies in a very real way here. If someone does not know, or cannot prove, that I have access to knowledge when a decision is made, the decision maker has a better chance of not being held directly responsible for unintended consequences that might flow from that decision. This concept has served politicians well throughout history. The world is changing, however.

We believe that the problems associated with the management of the Earth as a global community are much more complex than those associated with specific military actions. Control of the flow of information has value in tactical military situations. This control, however, inhibits scientists, planners, and resource managers as they attempt to provide a more basic understanding of the global system; and as they search for the environmental indices that facilitate early detection of global change and the factors that can lead to a more sustainable future.

The problem is how do we fight the fact that data and information concerning resources and our environment are perceived by some to be a basis for power? The intelligence community is not the only community at fault here. The intelligence community knows data are power but, so also do international organizations, civil agencies, academics, industries, and non-governmental organizations. How do we convince the affected parties, all of us, that the problems associated with sustainable development and global environmental change are so critical that we must, in so far as practical, break down the barriers to the flow of high quality geospatial information? These barriers inhibit our improved understanding of the current status of our global

resources base, and the factors that affect the quality of our environment. Even if we break down these barriers, even if we would allow maps to be generated, we must understand that the production of maps is a complex and expensive task. Here we are talking about base cartographic products and/or specific thematic coverages, e.g. topographic, land cover, land use, hydrology, land ownership, not road maps. We are also talking about standard products on a global scale, not just maps for countries such as the United States or the developed world.

If mapping were easy and inexpensive we would already have better maps. If mapping were simple we could have more up-to-date maps. The simple truth is, mapping is complex and expensive both in terms of personnel and financial resources. There is also a lot we do not understand about the type of mapping necessary to improve our understanding of the Earth system. Those of us who are involved in the process of developing the knowledge base in this area are also aware of the abysmal job we have done in trying to garner the resources required to correct this situation.

That there is considerable science left to do in mapping cannot be denied. We have not even come close to answering the basic questions in cartography associated with error/accuracy, scale or time to name an obvious few. As Estes and Star (1993) state "each of these are fundamental attributes of spatial data that require long range thorough research." Morrison, (1993) states: "the ability to visualize intangibles can create a new era for cartographers to explore and research." Such research is made all the more urgent by the rapidly expanding use of geographic information system (GIS). GIS's are dependent on the accuracy and currency of the base cartographic products that form the foundation of the systems database. As use of these systems expand, more and more of us will come to realize that the basic data we require is either not there, not current or not in a form which we can readily utilize. What can and must we do to improve this situation? This question leads to a series of concluding questions and comments.

Conclusions

Questions that arise here include:

1. Can we, all working together, break through the mapping paradox and balance the scientific need to understand the Earth as a system, with the need to protect national security and maintain national sovereignty?
2. Can those of us involved in land processes research rise above our work in our "own personal perfect pixel packages" and support something that can benefit us all?
3. Can we rise above the pursuit of the latest technological "flavor of the day" (where the bucks are) and work to help create a key set of national and global base cartographic products?
4. Can we educate the public, politicians and policy makers, key agency personnel, the Administration, and importantly our science community colleagues to dispel the myths:
   - That the maps needed to support our science do exist;
   - That mapping is easy; and,
   - That there is no science left to do in mapping? And,
5. Can we all work together to generate the resources required to support a significant expansion in the activities in this important area?

We must stop perpetuating the mapping myth. We need to be heard loud and clear. Adequate maps for land processes and many other science investigations do not exist! Mapping is not easy nor is it inexpensive! There is a lot of fundamental work to do in the mapping sciences! If we do not say these things, no one will.

As we enter the New Millennium we are confronted with a world where the actions of humans rival natural processes as agents of environmental change. As we move forward together toward a better appreciation of the nature and limits of our planetary resource base an important question arises. Can you imagine our world today without maps? Think about that for a moment before you decide. Step back, take your time, and contemplate what would be the implications of such a situation for political governance, commerce, environmental management, social institutions, cultural practices, let alone the sovereignty and security of Nations? How would our civilization function? Indeed, could our civilization function?

Now let's ask another question: can you imagine a world without National Mapping Organizations? Again, do not dismiss this rhetorical question too quickly. Think seriously about its implications and the potential alternatives, fueled by rapidly evolving technologies, that are beginning to come into existence in some Nations. Then turn it around. If you could design the charter of your National Mapping Organization today, what would you include? The whole field of mapping is undergoing a revolution. I believe National Mapping Organizations must change in response to advancing technology on the one hand and end user expectations on the other. What would you do to your organization to make the policy makers of your governments today so pleased with the products that its stature and funding would benefit measurably? Answering this is an exercise that is certainly deserving of a future conference.

One thing I am certain of, we must all become proactive within our own National systems. The Federal agencies I most often deal with, i.e. the United States Geological Survey, the National Aeronautics and Space Administration, the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, are all trying their best within the limitations of their charters and their resources to support our community. Yet, when we examine the need versus current activity, we conclude that changes must occur. National Mapping Agencies in all countries must be given expanded charters and increased resources if we are to reduce our current ignorance of National and global conditions.

The facts are that we need to put more resources toward the science, technology, research and development, and operational aspects of large scale global mapping. Such an investment can have significant economic and security returns. From an improved understanding and management of agricultural and forest resources to identification of public health problems and the protection of diversity. From improved demographic data which can pinpoint markets or be used to mitigate suffering in times of national disasters, to a better understanding of the factors affecting freshwater quantities and quality, up-to-date programs of mapping, and long term monitoring will help all of us.

Resources are, however, required to improve our global mapping capability, to generate the products required to support the science, planning, and resources management community. To insure that these resources are made available, each reader must become an activist. Role-up your sleeves and help.

Our world is changing. It always has and will continue to do so in the future. Some changes are local in nature with global impacts (e.g. deforestation). Other changes are global in character with local and regional impacts (e.g. greenhouse gasses). The common thread here is to understand the spatial and temporal dynamics of change, and to do so, we must have baselines. Some set of initial conditions away from which rates of change by areas of the globe can be measured. Maps are a key resource required for baselines against which land processes can be judged. Better map information in digital or analog form can improve our understanding of those factors that influence sustainable development and impact environmental quality. The whole mapping process needs to be reinvigorated. We need better, more accurate, more timely, more relevant map products. We need spatial information on subjects for which maps do not exist. More accurate maps can help us to better manage this planet, the only known closed life support system that has sustained life, as we know it, for longer than decadal time scales. Maps are too important to let the myth of their existence be perpetuated. Act now!

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Reports on achievements in surveying, mapping and charting in addressing national, subregional, regional and global issues, including: policy and institutional issues

Spatial data infrastructure and development: the World Bank approach

Submitted by the World Bank**

* E/CONF.93/1.
** Prepared by Frederic de Dinechin, land information specialist, the World Bank.

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Spatial data infrastructure and development

The World Bank Approach

Frederic de Dinechin
The World Bank

Content

- 1. What does SDI mean for the World Bank?
- 2. Why are SDIs important for the WB?
- 3. Key SDIs success factors
- 4. World Bank approach in Central America
- 5.The specific case of El Salvador land Administration project
- 6. Next steps

1. What does SDI mean for the World Bank ?

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- **SDI** describes the fundamental spatial datasets, the standards that enable them to be integrated, the distribution network to provide access to them, the policies and administrative principles that ensure compatibility between jurisdictions and agencies, and the people including user, provider and value adder who are interested at a certain level of area that starts at a local level and proceeds through state, national and regional levels to global level (by ANZLIC the Australian and New Zealand Land Information council).

Typical data in an SDI

- Geodetic framework
- Topography
- Hydrology
- Administrative Boundaries
- Geographic names
- Cadastre, Land tenure, value and land use

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Public and private data providers

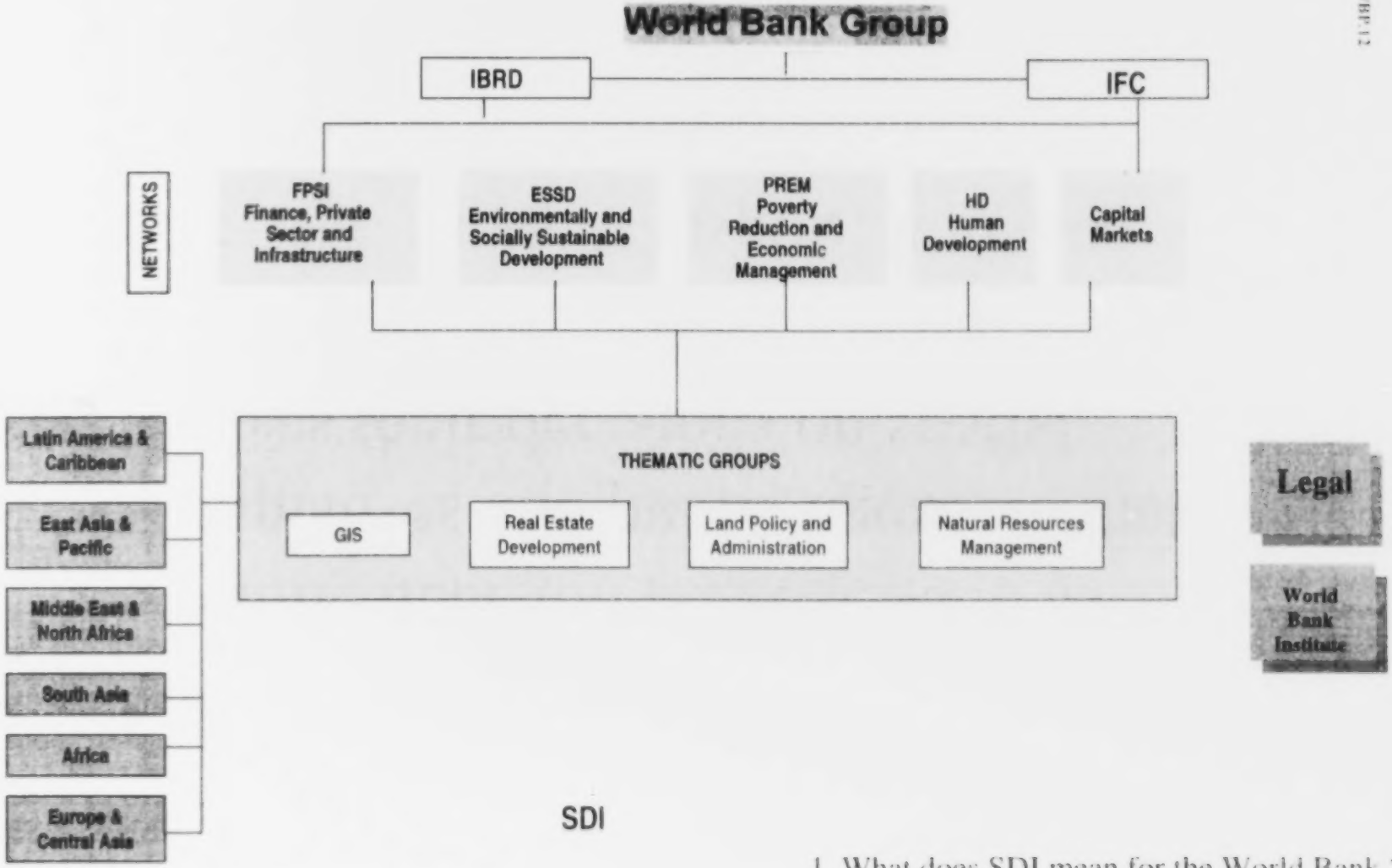
- Public agencies, including mapping agencies, national cadastre, property registry, statistical agency
- Local governments, such as provinces and municipalities
- Private stakeholders, such as utility, facility and telecommunications companies, private surveyors

Public and private data users

- Data providers
- Public decision makers, such as ministries and public agencies that bases their decisions on spatial information
- Private users: transport, logistics companies, banks, citizens
- Values adders, such as geo-marketing firms, GIS providers, etc.

ECONF35BP12

Knowledge structure across the World Bank



SDI

1. What does SDI mean for the World Bank ?

World Bank thematic groups sharing knowledge on SDI

- **The GIS TG** (www.worldbank.org/gis)
- **The Land Policy and Administration TG** (www.worldbank.org/landpolicy)
- **The land and Real Estate Initiative TG** (http://www.worldbank.org/html/fpd/urban//re_dev/red_body.htm)
- **The Natural Resources management TG** (http://www.worldbank.org/environment/topics.htm)

2. Why are SDIs important for the WB?

- Key for objective decision making and sound land based policy
- Support economic development
- Encourages socially and environmentally sustainable development
- Increasingly key components of many World Bank projects

Key for objective decision making and sound and land based policy

- knowledge of the location of an activity allows it to be linked to other activities or features that occur in the same nearby location
- location allows distances to be calculated, maps to be drawn, directions to be given and decisions to be taken about complex and inter related issues (Williamson, ''RSDI, An initiative to facilitate regional security)

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Support economic development:

- SDIs supports natural disaster management system and are consequently key to anticipate and reduce the economic burden of these disasters
- Well maintained parcel based property registry enables (1) national land market to be developped, (2) credit system to be fostered and (3) private investments on land to be secured

Land and real estate projects support economic development

- 7-20% of GDP is real estate investment
- 15-40% of household expenditure is on real estate
- 50-75% of national wealth is in real estate
- Leading indicator of GDP (residential development in the U.S...)
- 20-70% of credit is secured by real estate
- 85% of housing investment is financed through credit in OECD countries
- More than 90% of the assets of the poor are in land and real estate

Encourage environmentally and socially sustainable development

- SDIs facilitate comprehensive approaches of the territory, including rural/urban and public/private lands, natural resources, indigenous lands
- SDIs enable the implementation of integrated national and regional policies across sectors
- SDIs encourage basic social principles such as equity, security, transparency and efficiency

Increasingly key component in WB projects

- World Bank has approved 173 land related project from 1989 to 1999, including property rights/ land information systems, real estate development and mortgage finance, market regulation and fiscal Policy
- SDI components (geodesy, cadastre and land tenure information) counts generally for more than 50% of land administration projects total budget

Source: 1999 World Bank land and real estate assessment

3. SDIs key success factors

- Clarified legal framework
- Sustainable institutional arrangements and strategic partnerships
- New technologies to solve old problems

Clarified legal framework

- Providing a clear distribution of responsibilities among public and private stakeholders for the production and maintenance of spatial data
- Clarifying rights related to the access to public digital data
- Setting up legal provisions for data confidentiality and access to private data

Sustainable institutional arrangements and strategic partnerships

- Decentralization of services to better fit the final users needs

- Public and private partnerships are key:
  - in data production, maintenance, access and marketing;
  - to have access to cutting-edge technology

Sustainable institutional arrangements and strategic partnerships

- Designing SDI according to the business process it relates = mapping the process before mapping the earth
- Determine licensing and royalties policies serving long term objectives and not focus on short term commercial benefits
- Time is needed and project experience feedback required to adapt the legal and institutional framework

New Technology to solve old problems

- Quality approach = demand driven and not supply driven
- Capacity building with emphasis on human resources
- Sound use of information and communication technology
- Prioritize data layers and IT investments given the scarcity of financial resources

New Technology to solve old problems

- For data acquisition =
  - easy to use modern technology
  - satellite imagery and positioning systems
- For data management and maintenance =
  - Large choice of GIS and Date Base software
  - Access to local technical assistance/maintenance
- For data sharing, access and marketing=
  - outsourcing to private sector
  - e-services

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4. World Bank approach in Central America

- Countries: Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama
- More than 30 million people
- 500,000 sq.km
- Land administration programs and the Meso American Biological Corridor (MBC)

CA land administration programs

- Land administration portfolio
  - current = US$250 million
  - upcoming > US$500 million
- SDI component share
  - counts for about 50% to 60% of the project total costs
  - geodetic, large scale topographic and cadastral data
  - implementation of land information systems

CA workshops on land administration

- 6 workshops on land were organized for CA countries in collaboration with USAID and the WB:
  - 1996 workshop in Costa Rica
  - 1998 and 2000 workshop in El Salvador
  - 1999 workshop in Guatemala
  - 1998 and 2000 workshop in Washington DC

CA workshops on land administration

- Participants discussed common issues related to land including SDI issues such as:
  - legal and institutional issues related to SDI components
  - technical standards and norms for SDI components, including geodesy, base mapping and cadastral surveys
  - capacity building and training for spatial data experts
  - guidelines to procure SDI components

The MBC

- MBC portfolio, including medium and small scale environmental data:
  - current = US$ 100million
  - upcoming = US$ 100million
- SDI component
  - count for about 50% to 60% of the project total costs;
  - includes medium and small scale environmental data from satellite imagery

Two regional spatial infrastructure

- USAID supported geodetic network;
  - implemented by national mapping agency to fit with national programs
  - collaboration with national WB project to guaranty technical consistency.
- CA vegetation maps:
  - CA, including Belize
  - 1/25,000 scale maps from Landsat satellite imagery
  - 60 land use classes

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5. The specific case of El Salvador Land Administration project

- El Salvador = 20,000 sq.km, 6 million inhabitants
- Project amount = US$ 70 million
- IBRD loan = US$50 million
- Time frame: 1997 - 2002

Project objectives

- Registering all properties, urban and rural, private and public

- Strengthening the land registry, national cadastre and mapping agency to keep information updated and self finance the maintenance

Project components

- Institutional strengthening = US$6.1M
- Institutional decentralization = US$4.5M
- Mapping of land data acquisition = US$15.1M
- Land record regularization = US$35.4M
- Project administration = US$8.7M

What is key in terms of SDI

- A unique institutional structure, the CNR (Centro Nacional de Registros) comprised by:

  – property registry
  – directorate of cadastre
  – mapping agency
  – intellectual property registry
  – commercial registry

What is key in terms of SDI

A technically strengthened institution

- Modern digital mapping & surveying equipment
- SIRyC = fully computerized cadastral and registral information system
- SIG = national geodetic and topographic computerized data base
- SIIGE = management information system

What is key in terms of SDI

- Complete large scale coverage of the entire territory
  - new national geodetic network, including two CORS provided by USAID;
  - 1:1,000 scale urban maps and 1:5,000 orthophotmaps for the entire country in a digital format;
  - 1 meter accuracy rural and 50cm urban cadastral surveys for the entire country

What is key in terms of SDI

- Partnership with municipalities for data maintenance
  - CNR provides to municipalities the first topographic and cadastral information
  - Municipalities provide the CNR with cadastral updates.

6. Next steps

- Carry out economic study to evaluate the economic value and utility of SDIs and showing SDI as key infrastructure for economic development
- Include SDI in the bank strategic documents = CAS and ESW
- Disseminate more intensively SDI benefits throughout the WB knowledge network

Next step

- Improve and harmonize SDI TORs and Tech. Specs in WB projects

- Develop partnership between WB and other SDI stakeholders, including the UN, the PC on SDI for the America